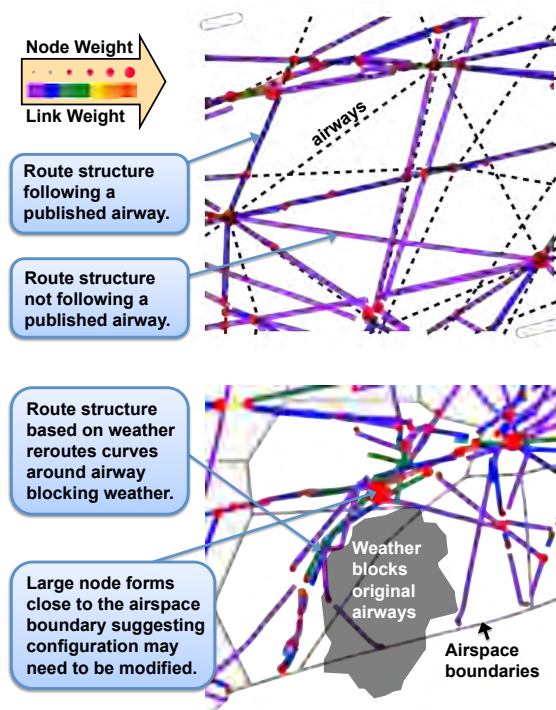# DEFINING DYNAMIC ROUTE STRUCTURE

Motivation

The current airspace sector design evolved over decades, driven by human-centered separation assurance and an airway system of ground-based navaids. The future system is migrating toward more direct and flexible user-preferred routing. Automation tools and dynamic reconfiguration of airspace boundaries will facilitate controllers to adapt to changing weather and traffic conditions and increase controller staffing flexibility. Structure-based abstractions of traffic conditions are necessary both to trigger and guide airspace boundary changes and to quickly give controllers situational awareness. Route structure is an abstraction of the air traffic network based on standard flows and their intersections at critical points. This research presents a method of quickly determining route structure from flight tracks.

Flight tracks → Intersections → Clusters → Nodes → Links
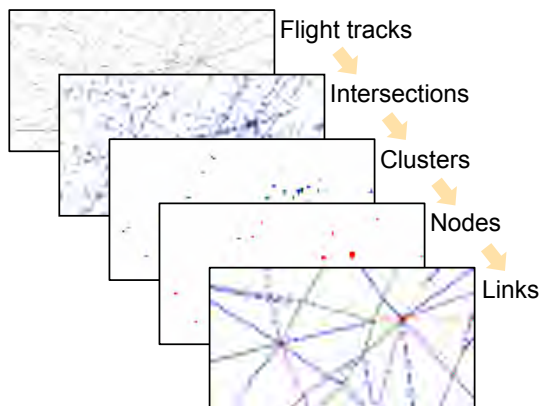
Method

Given a set of projected flight tracks, individual merge and diverge intersections between pairs of flights are identified, clustered, filtered, and grouped into nodes of a route structure network. Link paths are placed between nodes to represent major traffic flows. In addition to defining a three dimensional structure that can follow traffic patterns around weather obstacles, node and link weights define the most heavily used parts of the structure. Nodes and links are weighted by the number of individual intersections or following flight traffic they represent.

Node Weight

Link Weight

Route structure following a published airway.

Route structure not following a published airway.

airways

Dynamic Route Structure Analysis

Route structures were generated for 4-hour time windows of track data shifted every 2 hours to demonstrate how route structure can be updated dynamically. Links and nodes appeared and increased in weight as flight traffic increased. When airways began to saturate, more and more links began to appear where airways had not been published. The standard deviation of flights tracks was 2 nmi from links and 4.7 nmi from nodes.

Route structure based on weather reroutes curves around airway blocking weather.

Large node forms close to the airspace boundary suggesting configuration may need to be modified.

Weather blocks original airways

Airspace boundaries

Potential Benefits

Dynamically generated route structures could be useful in guiding dynamic airspace configuration to accommodate traffic volume changes or weather reroutes. They may also help controllers in generic airspace quickly gain situational awareness under dynamically changing airspace and traffic conditions.

Zelinski, S. and Jastrzebski, M. 2010. Defining Dynamic Route Structure for Airspace Configuration, *27th International Congress of the Aeronautical Sciences*, Nice, France.